some degree. That is, in an anisotropic conductive film of the present invention, the conductive parts are of porous structure.

Therefore, the anisotropic conductive film of the present invention has elastic recovery property upon compression as well as elasticity, not only in the base film but also in the conductive parts, and can be applied to repeated use. Also, the anisotropic conductive film of the present invention can be made conductive in the film thickness direction at a low compression load. Moreover, in the anisotropic conductive film of the present invention, the conductive parts and pitches between the conductive parts can be made finer. Thus, the present invention has been completed based on such discovery and knowledge.

An anisotropic conductive film is provided according to the present invention, wherein an electrically insulative porous film made of synthetic resin is used as a base film and conductive metal plating particles are formed continuously adhering to the resinous parts of porous structure in the wall surfaces of through-holes piercing from a first surface to a second surface at plural positions of the base film, whereby conductive parts which can be provided with conductiveness in the film thickness direction are provided independently in a manner such that the conductive parts maintain the porous structure of the porous film.

Also, a method of making an anisotropic conductive film is provided according to the present invention, wherein conductive metal particles formed by plating are adhered continuously to the resinous parts of porous structure in the wall surface of the through-holes piercing through from a first surface to a

second surface at plural positions of a base film made of an electrically insulative porous film formed synthetic resin, whereby conductive parts which can be provided with conductiveness in the film thickness direction are provided independently in a manner such that the conductive parts maintain the porous structure of the porous film.

Moreover, according to the present invention, the following methods 1 – 3 of manufacturing anisotropic conductive films are provided:

1. A method of manufacturing an anisotropic conductive film, which method is characterized in that conductive parts capable of being afforded with conductiveness in the film thickness direction are provided independently of each other by adhering conductive metal particles of electroless plating continuously to the resinous parts of porous structure in the wall surfaces of through-holes piercing through from a first surface to a second surface at plural positions of a base film made of an porous polytetrafluoroethylene film formed from synthetic resin, wherein the conductive parts maintain the porous structure of the porous film, the method comprises:

(1) a step of forming a three layer laminated body by fusion-bonding polytetrafluoroethylene films (B) and (C), which are to be mask layers, to both surfaces of a base film consisting of a porous polytetrafluoroethylene film (A);

(2) a step of forming through-holes arranged in a pre-determined pattern in the laminated body by irradiating the surface of one of the mask layers with synchrotron radiation rays or laser beams having a wavelength of 250 nm or less through a light shielding sheet having a plurality of optically transparent

parts provided independently of each other in the pre-determined pattern;

(3) a step of adhering catalytic particles for facilitating chemical reduction reaction to resinous parts of porous structure existing in the whole surface, including the wall surfaces of the through-holes, of the laminated body;

(4) a step of peeling off the mask layers from both surfaces of the base film; and

(5) a step of adhering conductive metal particles by electroless plating continuously to resinous parts having porous structure in the wall surfaces of the through-holes in a manner such that the conductive parts maintain the porous structure of the porous films.

2. A method of manufacturing an anisotropic conductive film, which method is characterized in that conductive parts capable of being afforded with conductiveness in the film thickness direction are provided independently of each other by adhering conductive metal particles of electroless plating continuously to the resinous parts of porous structure in the wall surfaces of through-holes piercing through from a first surface to a second surface at plural positions of a base film made of an porous polytetrafluoroethylene film formed from synthetic resin, wherein the conductive parts maintain the porous structure of the porous film, the method comprises:

(I) a step of forming a three layer laminated body by fusion-bonding polytetrafluoroethylene films (B) and (C) as mask layers to both surfaces of a base film consisting of a porous polytetrafluoroethylene film (A);

(II) a step of forming through-holes by using an ultrasonic head having at least one rod at the tip thereof and pressing the tip of the rod so as to apply ultrasonic wave energy to the surface of the laminated body, the through-holes being arranged in a pattern in the laminated body;

(III) a step of adhering catalytic particles for facilitating chemical reduction reaction to resinous parts of porous structure existing in the whole surface, including the wall surfaces of the through-holes, of the laminated body;

(IV) a step of peeling off the mask layers from both surfaces of the base film; and

(V) a step of adhering conductive metal by electroless plating to resinous parts having porous structure in the wall surfaces of the through-holes in a manner such that the conductive parts maintain the porous structure of the porous film.

3. A method of manufacturing an anisotropic conductive film, which method is characterized in that conductive parts capable of being afforded with conductiveness respectively in the film thickness direction are provided independently of each other in a piercing manner from a first surface to a second surface by adhering conductive metal to resinous parts having porous structure at plural positions in a base film made of a porous polytetrafluoroethylene film, wherein the method comprises:

(i) a step of forming a three layer laminated body by fusion-bonding polytetrafluoroethylene films (B) and (C) as mask layers to both surfaces of a base film consisting of a porous polytetrafluoroethylene film (A);

(ii) a step of infiltrating liquid into porous parts of the laminated body and freezing the liquid;

(iii) a step of forming through-holes in a pattern in the laminated body by using an ultrasonic head having at least one rod at the tip thereof and pressing the surface of the laminated body with the tip of the rod so as to apply ultrasonic wave energy thereto;

(iv) a step of returning the freezing in the porous parts to liquid by increasing the temperature of the laminated body and removing the liquid;

(v) a step of adhering catalytic particles for facilitating chemical reduction reaction to resinous parts of porous structure existing in the whole surface, including the wall surfaces of the through-holes, of the laminated body;

(vi) a step of peeling off the mask layers from both surfaces of the base film; and

(vii) a step of adhering conductive metal by electroless plating to resinous parts having porous structure on the wall surfaces of the through-holes.

According to the present invention, it is possible to provide an anisotropic conductive film which has elasticity in the film thickness direction and in which conduction can be afforded in the film thickness direction with a low compression load, and moreover which is capable of elastic recovery and suitable for repeated use. Also, an anisotropic conductive film in which the sizes and pitches of the respective conductive parts can be made finer is provided according to the present invention. The anisotropic conductive film of the present invention is capable of exhibiting electrical continuity in the film thickness direction with a low compression load, and is an anisotropic conductive film mainly suitable for an inspection of semiconductor wafers and the like, and moreover even with repeated application of load, the film thickness thereof can recover because of elasticity, thereby allowing repeated use for the inspection.

Brief Description of the Drawings

Figure 1 is a perspective view of a porous film in which through-holes are formed.

Figure 2 is a sectional view illustrating a condition in which conductive parts are formed with conductive metal particles adhered to the resinous part of porous structure on the respective walls of through-holes in an anisotropic

CLAIMS

1. (Amended) An anisotropic conductive film, wherein an electrically insulative porous film made of synthetic resin is used as a base film, and conductive metal plating particles are formed continuously adhering to resinous parts of porous structure in the wall surfaces of through holes piercing through from a first surface to a second surface, whereby conductive parts capable of being provided with conductiveness in the film thickness direction are formed independently at plural positions of the base film, the conductive parts maintaining the porous structure of the porous film.
2. (Deleted)
3. (Deleted)
4. (Deleted)
5. (Amended) An anisotropic conductive film according to claims 1 , wherein the porous film is a porous polytetrafluoroethylene film.
6. (Amended) An anisotropic conductive film according to claim 5, wherein the resinous parts of porous structure are fibrils and nodes, each consisting of polytetrafluoroethylene.
7. (Deleted)
8. (Deleted)
9. (Amended) A method of making an anisotropic conductive film, wherein conductive metal particles formed by plating are adhered continuously to

resinous parts having porous structure in the wall surfaces of through holes piercing from a first surface to a second surface at plural positions in a base film made of an electrically insulative porous film consisting of synthetic resin, whereby conductive parts capable of being afforded with conductiveness respectively in the film thickness direction are provided independently of each other, the conductive parts maintaining the porous structure of the porous film.

10. (Deleted)

11. (Amended) A manufacturing method as set forth in claim 9, wherein the through-holes piercing from a first surface to a second surface are formed at plural positions of the base film by irradiating synchrotron radiation rays or laser beams having a wavelength of 250 nm or less.

12. (Amended) A manufacturing method as set forth in claim 9, wherein the through-holes piercing from a first surface to a second surface are formed by ultrasonic wave processing at plural positions of the base film.

13. (Deleted)

14. (Deleted)

15. (Amended)A manufacturing method as set forth in claim 11 or 12, wherein conductive metal is adhered by electroless plating through chemical reduction reaction, after catalytic particles for facilitating the chemical reduction reaction are adhered, to the resinous parts of porous structure at the wall surfaces of through-holes.

16. (Amended)A manufacturing method as set forth in any one of claims 9,

11, 12, and 15, wherein the porous film is a porous polytetrafluoroethylene film.

17. (Amended)A method of making an anisotropic conductive film, wherein conductive parts capable of being afforded with conductiveness respectively in the film thickness direction are provided independently of each other by adhering conductive metal particles of electroless plating continuously to resinous parts having porous structure in the wall surfaces of through holes piercing from a first surface to a second surface at plural position in a base film consisting of a porous polytetrafluoroethylene film, and wherein the conductive parts maintain the porous structure of the porous film,

the method comprising the steps of:

(1) forming a three layer laminated body by fusion-bonding polytetrafluoroethylene films (B) and (C), which are to be mask layers, to both surfaces of a base film consisting of a porous polytetrafluoroethylene film (A);

(2) forming through-holes arranged in a pre-determined pattern in the laminated body by irradiating the surface of one of the mask layers with synchrotron radiation rays or laser beams having a wavelength of 250 nm or less through a light shielding sheet having a plurality of optically transparent parts provided independently of each other in the pre-determined pattern;

(3) adhering catalytic particles for facilitating chemical reduction

reaction to resinous parts of porous structure existing in the whole surface, including the wall surfaces of the through-holes, of the laminated body;

(4) peeling off the mask layers from both surfaces of the base film; and

(5) adhering conductive metal particles by electroless plating continuously to resinous parts having porous structure in the wall surfaces of the through-holes in a manner such that the conductive parts maintain the porous structure of the porous films.

18. (Amended)A method of making an anisotropic conductive film, wherein conductive parts capable of being afforded with conductiveness respectively in the film thickness direction are provided independently of each other by adhering conductive metal particles of electroless plating to resinous parts having porous structure in the wall surfaces of through holes piercing from a first surface to a second surface at plural positions in a base film consisting of a porous polytetrafluoroethylene film, and wherein the conductive parts maintain the porous structure of the porous film,

the method comprising the steps of:

(I) forming a three layer laminated body by fusion-bonding polytetrafluoroethylene films (B) and (C) as mask layers to both surfaces of a base film consisting of a porous polytetrafluoroethylene film (A);

(II) forming through-holes by using an ultrasonic head having at least

one rod at the tip thereof and pressing the tip of the rod so as to apply ultrasonic wave energy to the surface of the laminated body, the through-holes being arranged in a pattern in the laminated body;

(III) adhering catalytic particles for facilitating chemical reduction reaction to resinous parts of porous structure existing in the whole surface, including the wall surfaces of the through-holes, of the laminated body;

(IV) peeling off the mask layers from both surfaces of the base film; and

(V) adhering conductive metal particles by electroless plating continuously to resinous parts having porous structure on the wall surfaces of the through-holes in a manner such that the conductive parts maintain the porous structure of the porous film.

19. (Amended)A method of making an anisotropic conductive film, wherein conductive parts capable of being afforded with conductiveness respectively in the film thickness direction are provided independently of each other in a piercing manner from a first surface to a second surface by adhering conductive metal to resinous parts having porous structure at plural positions in a base film consisting of a porous polytetrafluoroethylene film,

the method comprising the steps of:

(i) forming a three layer laminated body by fusion-bonding polytetrafluoroethylene films (B) and (C) as mask layers to both surfaces of a base film consisting of a porous polytetrafluoroethylene film (A);

(ii) infiltrating liquid into porous parts of the laminated body and

freezing the liquid;

(iii) forming through-holes in a pattern in the laminated body by using an ultrasonic head having at least one rod at the tip thereof and pressing the surface of the laminated body with the tip of the rod so as to apply ultrasonic wave energy thereto;

(iv) returning the freezing in the porous parts to liquid by increasing the temperature of the laminated body and removing the liquid;

(v) adhering catalytic particles for facilitating chemical reduction reaction to porous parts existing in the whole surface, including the wall surfaces of the through-holes, of the laminated body;

(vi) peeling off the mask layers from both surfaces of the base film; and

(vii) adhering conductive metal by electroless plating to resinous parts having porous structure on the wall surfaces of the through-holes.

20. A manufacturing method as set forth in claim 19, wherein water or organic solvent is used as the liquid to be infiltrated into the porous parts in the step (ii) above.

21. (Amended)A manufacturing method as set forth in any one of claims 9, 11,12, and 15 to 20, wherein for adhering conductivity metal to the resinous parts of porous structure, conductive metal particles with a particle diameter of 0.001 - 5 μm are adhered at adhesion quantity of 0.001 - 4.0 g/ml(resin).